4. STRUCTURAL DESIGN

4.1 **Purpose of Criteria**. The purpose of these criteria is to create uniform CESPA vertical construction documents for ease of review to minimize review comments and for uniformity in the field amongst the numerous projects CESPA may have under construction at one time. For reviews this uniformity reduces the review time spent by CESPA personnel. This in turn minimizes the time spent by the A/E on the review comments because the comments will be minimized due to the uniformity. Less review comments usually indicates a job well done.

4.2 **Philosophy.** The CESPA Structural Unit has a philosophy of designing, detailing and specifying structural elements only once in the structural documents. This helps to eliminate modifications to the structural contract documents based on conflicting information in the documents. The A/E is encouraged to use this same philosophy in the creation of the documents for this project. A number of the design and detailing requirements in this document are geared toward this philosophy. The CESPA Structural Unit will review the structural documents using this philosophy for in-house and A/E designs. This helps to add standardization to the structural contract documents within the CESPA for the office and for the field. This standardization helps to speed-up the review process and helps to minimize the review comments. It should also be noted that this document will be used as a checklist for reviews.

4.3 **Description.** This criteria document is not to be used for residential housing projects. The structural criteria established herein shall be used for structural loadings, design and installation of all structural systems and foundations, including manufacturing, erection, supervision, testing, and quality assurance of the completed installation of this project. All structural calculations shall be checked and initialed as such by a registered structural engineer other than the original design engineer. All structural calculations shall be sequentially numbered for ease of referencing for all stages of submittal. One method of numbering the structural calculations such that calculation sheets can be added for future submittals is to use a prefix numbering system, e.g. “R” for roofs, “RB for roof beams, “L” for lateral, “F” for foundations, etc. Refer to the Geotechnical Foundation Design Analysis (FDA) for all foundation requirements and recommendations except as stated otherwise in this document. The structural work consists of design and construction of, but not necessarily limited to the following items.

a. Building Foundations.
b. Load Bearing and Non-Load Bearing Masonry Walls.
c. Load Bearing, Non-Load Bearing and Soffit or Fascia Steel Stud Walls.
d. Vertical Framing Members.

e. Horizontal Framing Members, including roof and floor decks and diaphragms, and roof and floor framing members.
f. Connection details of structural materials.
g. Special conditions, such as expansion, construction, and contraction joints, changes in floor levels, miscellaneous structures such as antenna platforms, catwalks, etc.
h. Connection provisions for architectural, mechanical, and electrical elements.
i. Site screen and security walls and foundations.
j. Interior and exterior equipment pads.
k. Site concrete – retaining walls, loading docks, waste bin pads, etc.

4.4 **Metrication.** English inch-pound (I-P) values are used by CESPA for drawings, specifications and calculations. Products that are manufactured to Metric dimensions or have an industry recognized Metric designation should be given in Metric (SI) values.

4.5 **Guide Specifications.** The structural related specifications listed have been modified for CESPA regional conditions and requirements and shall be used in the design and construction documents of this project. Only use CESPA standard structural guide specifications, all others will be rejected and will not be reviewed. The CESPA standard structural guide specifications identification number at the top of the first page shall be preceded by “CESPA”, e.g. CESPA-03 31 00 (latest edition date). If the specification section number is not preceded by “CESPA” it shall not be used for editing on the structural portion of CESPA projects. For electronic copies of the required CESPA structural guide specifications contact Ms. Pam Wagener with the CESPA at 505-342-3370, fax 505-342-3497 or email at pamela.s.wagener@usace.army.mil. These guide specifications are working files and can be revised by CESPA at anytime without notice. The A/E shall edit these specifications as applicable to fit project specific requirements. The project specific requirements shall not be less than the minimum requirements specified in this document except where this document references a requirement contained in the CESPA structural guide specifications. In this case the guide specifications requirement will be a requirement of these criteria. If additional structural related specifications are required, the A/E shall contact the Government Project Manager to furnish the needed specification(s). In all of the following listed specification sections in Paragraph 1.2 – SUBMITTALS there is an introductory paragraph that reads as follows:

“Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government Office codes for Army projects using the Resident Management System (RMS) are as follows: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. The editor of the specifications shall edit each submittal requirement for the appropriate review office.

[Editor Note] For all RFP projects the submittal coding shall be "G, A/E."

a. 01 45 35 - SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.
b. 03 11 13 - STRUCTURAL CONCRETE FORMWORK.
c. 03 15 13 - EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS.
d. 03 20 01 - CONCRETE REINFORCEMENT.
e. 03 31 00 - CAST-IN-PLACE STRUCTURAL CONCRETE.
f. 03 30 04 – CONCRETE FOR BUILDING CONSTRUCTION (MINOR REQUIREMENTS) (Do not use on projects containing more than 25 cubic yards).
g. 03 31 01 - CAST-IN-PLACE STRUCTURAL CONCRETE (For Holloman AFB, White Sands Missile Range, and within the Tularosa Basin of New Mexico).
h. 03 36 50 – POST TENSION CONCRETE.
i. 03 41 33 – PRECAST/PRESTRESSED CONCRETE FLOOR AND ROOF UNITS.
j. 03 45 01 – PRECAST ARCHITECTURAL CONCRETE.
k. 03 47 13 - TILT-UP CONCRETE
l. 04 20 00 - MASONRY.
m. 04 21 13 - NONBEARING MASONRY VENEER/STEEL STUD WALLS.
n. 05 05 23 - WELDING, STRUCTURAL.
o. 05 12 00 - STRUCTURAL STEEL.
p. 05 21 02 - STEEL JOISTS.
q. 05 30 00 - STEEL DECKING.
r. 05 40 00 - COLD-FORMED STEEL FRAMING.
s. 05 50 00 – METAL: MISCELLANEOUS AND FABRICATIONS.
t. 06 10 00 – ROUGH CARPENTRY (for wood structures only).
u. 13 48 00 - SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT (See paragraph titled "Minimum Seismic Bracing Requirements for Equipment" in this document).
v. 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT
w. 13 34 19 – PRE-ENGINEERED METAL BUILDINGS.
x. 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT
y. 31 63 16 - AUGER CAST GROUT PILES.
z. 31 63 26.16 20 DRILLED FOUNDATION CAISSONS (PIERS)

4.6 **Drafting Standards.** These structural drafting standards shall take precedence over all other referenced drafting standards in this criteria document to include the ERDC/ITL TR-01-6 - "A/E/C CADD Standard".

[Editor's Note: For RFP document drafting standards replace the wording of the paragraph titled "Drafting Standards" and all its subparagraphs with a paragraph to read as follow, "**Drafting Standards Specific to Structural Drawings**. Reference Appendix ?? for drafting standards specific to structural drawings. These structural drafting standards shall take precedence over all other referenced drafting standards in this criteria document to include the ERDC/ITL TR-01-6 - "A/E/C CADD Standard"." Contact Pam Wagener for the specific appendix number or letter.]

4.6.1 **Sheet Numbering.** All sheet numbering shall comply with ERDC/ITL TR-01-6 – "A/E/C CADD Standard", page 17, Figure 6 and Table 6. The

"Discipline Designator" (Figure 6) shall be an "S" for ALL structural drawing sheets.

4.6.2 **Reference Bubbles.**

4.6.2.1 **Structural Plans, Sections, and Details**. All structural plans, sections, and details shall be identified with a reference bubble. The respective reference bubbles shall be referenced from structural notes, plans, or other sections and details. The number and lettering sequence shall start with number "1" and letter "A" on each respective drawing sheet.

4.6.2.2 **Two-Part Reference bubbles**. All reference bubbles shall be divided up into 2 parts.

4.6.2.2.1 **Part One.** Part one is the upper half of the bubble and is the reference number or letter of the bubble. Sections shall be numbers. Details and plans shall be letters.

4.6.2.2.2 **Part Two.** Part two is the lower half of the bubble. When the bubble is shown on a section, detail or plan, part two is the number of the sheet where the section is drawn. When the bubble is on the sheet where the section, detail or plan is drawn part two is the number of the sheet where the detail was referenced from. In this case Part 2 could be numerous sheet numbers if the section, detail or plan is referenced at more than one location in the drawings. The text shall not be made smaller than 1/8" in height to fit into the two sections of the bubble. Break the lower bubble line to accommodate more than one sheet number.

4.6.3 **Foundation and Framing Plan Dimensioning.** All structural foundation and framing plans shall be FULLY dimensioned. No dimensions shall be referred back to the drawings of another discipline. Also, no dimensions shall be referenced back to a foundation plan from a framing plan or visa versa. All plans shall contain overall dimensions for the major parts of the building and the overall length of the building.

4.6.4 **Grid Lines.** All foundation and framing plans shall contain grid lines in both directions and on diagonals (if necessary for angular portions of the structure) for bearing and shear walls, beam and column lines, ribbed mat slab ribs, walls around stairs and elevators, pad footings and at all edges of the building. Each grid line shall be identified as to what element it locates with the use of keyed notes. Do not provide grid lines or location dimensioning for thickened slabs that would be provided under interior masonry partitions. All grid lines shall project from the grid line identification bubble to the element it is identifying.

4.6.5 **Scale of Foundation and Framing Plans.** All foundation and framing plans and overall building sections shall be drawing to a scale of at least 1/8"= 1'-0".

4.6.6 **Scale of Sections and Details.** All foundation sections and details shall be drawn at a minimum scale of 3/4" = 1'-0". All roof sections and details shall be drawn at a minimum scale of 1-1/2” = 1’-0”. The reason for these scale requirements is so the sections and details can be easily read when the drawings are plotted at one-half size.

4.6.7 **Lettering.** All lettering shall be uppercase and at least 1/8-inch in height when plotted at full size. This includes lettering contained within reference bubbles.

4.6.8 **Standard Drawings.** The drawings shall contain CESPA standard structural notes and typical details. These notes and details shall contain a list of the design loading criteria, a list of the strengths of the engineering materials used, the soil design property values, and any other data that would be pertinent to remodeling and/or future additions. These standard sheets are coordinated with the CESPA guide specifications such that conflicts between the two are minimized – reference the previous paragraph titled “**Philosophy**”. For electronic copies of these standard structural drawings go to web site http://www.spa.usace.army.mil/ec/cadd/index.htm click on “Discipline Specific Requirements” and click on “Structural”. The contact for these drawings is Mr. Lance Faerber with the CESPA at 505-342-3345, Fax 505-342-3497 or email at Lance.r.Faerber@usace.army.mil. These standard drawings are in MicroStation or AutoCAD format. The minimum requirements for the respective notes are described in detail throughout this document. These standard drawings are working files and can be revised by CESPA at anytime without notice.

4.6.8.1 Reference CESPA Standard Structural Drawing Sheets S001, S002, S003, S004 & S005 for required minimum standard structural notes and typical details. These five sheets shall be placed as the first five sheets of the structural drawings (no exceptions) no matter the size of the drawing sheets. There are two sets of Sheets S001, S002, S003, S004 & S005, one for reinforced ribbed mat slabs (RRMS) and one for “Floating” or “Turned Down Edge” slab-on-ground foundation systems as noted on the respective drawings.

4.6.8.2 Standard sheets RM1, RM2 & RM3 are for RRMS foundation systems for use on layout of the ribs (sheet RM1) and typical foundation details (sheet RM2 and RM3).

4.6.8.3 Standard sheets RM4 & RM5 are for “Monolithic Floor Slab-On-Ground with Continuous Turned-Down-Edge Footings, Integral Interior Continuous Footings, and Integral Spread (Spot) Footings System” foundation system plans and typical details.

4.6.8.4 Standard sheets RM6 & RM7 are for “Housing Turned Down Edge” system foundation plans and typical details.

4.6.8.5 Standard sheet numbers with prefix “T” are standard foundation details for water and oil storage tanks.

4.6.8.6 Standard sheet numbers with prefix “HC” are standard sheets for precast concrete hollow core floor and roof planks.

4.6.9 **Keyed Notes.** Keyed notes are required for all referencing on the structural drawings except for the standard sheets S001, S002, S003, S004 and S005 that may or may not use keyed notes.

4.7 **References.** Design methods and allowable stresses or load factors for the various structural materials shall be in accordance with current Unified Facilities Criteria (UFC), Air Force engineering and technical manuals (TM), Corps of Engineers technical instructions (USACE TI-), engineering regulations (ER-), engineering technical letters (ETL-) and industry standard codes and specifications (AISC, ACI, SJI, etc.). For housing projects the International Building Code (IBC) shall be the required code to use for the structural design, except for RRMS foundations systems. For housing RRMS foundation systems this document will control. Most of the Corps of Engineers publications are available at web site http://www.usace.army.mil/inet/usace-docs/. Most of the UFC documents are available at web site http://65.204.17.188/report/doc_ufc.html. Recommendations made in the codes, specifications and industry standards in this paragraph are requirements of this document, unless specified otherwise. The references used for the project design and contract documents shall be included in any design analysis required for this project.

4.7.1 **COE Engineering Manuals.**

4.7.1.1 UFC 1-200-01 – General Building Requirements, 27 November 2007.

4.7.1.2 UFC 3-310-1 – Structural Load Data, 25 May 2005.

4.7.1.3 UFC 3-310-04 – Seismic Design for Buildings, 22 June 2007.

4.7.1.4 UFC 3-310-07A - Design of Cold-Formed Load Bearing Steel Systems and Masonry Veneer/Steel Stud Walls, 19 June 2006.

4.7.1.5 UFC 3-310-05A – Masonry Structural Design for Buildings, 1 March 2005.

4.7.1.6 UFC 3-320-02A – Design and Construction of Conventionally Reinforced Ribbed Mat Slabs (RRMS), 1 March 2005.

4.7.1.7 UFC 3-320-03A - Structural Considerations for Metal Roofing, 1 March 2005.

4.7.1.8 UFC 3-320-04A - Metal Building Systems, 1 March 2005.

4.7.1.9 UFC 3-320-06A Concrete Floor Slabs on Grade Subjected to Heavy Loads, 1 March 2005.

4.7.1.10 UFC 3-330-03A - Concrete Floor Slabs on Grade Subjected to Heavy Loads – 1 March 2005

4.7.1.11 UFC 4-010-01 – DOD Minimum Antiterrorism Standards for Buildings, 8 October 2003.

4.7.1.12 ETL 1110-3-447 - Engineer of Record and Design Responsibilities, Engineer Technical Letter (ETL), 30 Apr 1993.

4.7.1.13 ER 1110-345-53 - Structural Steel Connections, Engineer Regulation, 22 July 1994.

4.7.1.14 ERDC/ITL TR-01-6 - The CADD/GIS Technology Center, "A/E/C CADD Standard", Release 2.0, September 2001.

4.7.2 **Codes and Specifications.**

4.7.2.1 Manual of Steel Construction by the American Institute of Steel Construction (AISC), Thirteenth Edition.

4.7.2.2 AISC 811-97, Design Guide 11, Floor Vibration Due to Human Activity, 1997.

4.7.2.3 International Building Code (IBC) 2006, (Referred to as the IBC in this document), International Code Council.

4.7.2.4 ACI 318-05/318R-2008, Building Code Requirements for Structural Concrete, American Concrete Institute (ACI).

4.7.2.5 Standard Specifications And Load Tables for Steel Joists and Joist Girders by the Steel Joist Institute (SJI), 42nd Edition, December 2005.

4.7.2.6 Technical Digest No. 5, VIBRATION of steel joist-concrete slab floors by the Steel, Joist Institute (SJI), March 1988.

4.7.2.7 ASCE/SEI 7-05 - Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers (ASCE).

4.7.2.8 AISI-SG03-3, Cold-Formed Steel Design Manual Set, American Iron and Steel Institute (AISI), 2002.

4.7.2.9 AWS D1.1/D1.1M, Welding Handbook, American Welding Society (AWS), 2008.

4.7.2.10 Diaphragm Design Manual – DDM03 – Third Edition, Steel Deck Institute (SDI), September 2004.

4.7.2.11 SDI - Design Manual for Composite Decks, Form Decks and Roof Decks - No. 31, November 2007.

4.7.2.12 AWWA D-100-05 - Welded Carbon Steel Tanks for Water Storage, American Water Works Association (AWWA), 2005.

4.7.2.13 API 650 - Welded Steel Tanks for Oil Storage, Eleventh Edition, American Petroleum Institute (API), June 2007.

4.7.2.14 PCI MNL-116-99 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, Fourth Edition, Precast/Prestressed Concrete Institute (PCI).

4.7.2.15 PCI MNL-117-96 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, Third Edition.

4.7.2.16 PCI MNL-120-04, PCI Design Handbook, Sixth Edition.

4.7.2.17 PCI MNL-122-07 - Architectural Precast Concrete, Third Edition.

4.7.2.18 PCI MNL-126-98 - Manual for the Design of Hollow Core Slabs.

4.7.2.19 Design and Construction of Post-Tensioned Slabs-on-Ground by the Post Tensioning Institute (PTI), Third Edition, 2005.

4.8 **Design Loads.**

4.8.1 **General.** Design loads shall be included in the structural notes on the contract drawings as shown in CESPA Standard Structural Drawing Sheet S001 "General Notes".

4.8.1.1 **Dead Loads**.

4.8.1.1.1 The structural system shall be designed and constructed to safely support all dead loads, permanent or temporary, including but not limited to self-weight, partitions, insulation, ceiling, floor covering, and all equipment that is fixed in position. All loads and load case combinations shall be in accordance with ASCE 7. Load factors for designs shall be based on the applicable material design standard (e.g., reference ACI-318 for concrete, AISC Manual of Steel Construction for structural steel, etc.).

4.8.1.1.2 For pre-engineered metal buildings include a minimum collateral dead load of 10 psf in addition to all calculated dead loads.

4.8.1.2 **Live Loads**.

4.8.1.2.1 Roofs shall be designed to support live loads; snow loads, including drifting snow, sliding snow, and rain on snow; and support wind loads including components and cladding in accordance with ASCE 7.

4.8.1.2.2 If the design roof snow loading is less than 20 psf, a minimum roof live loading for construction and maintenance of 20 psf shall be used for design of the structure. This roof live loading is in lieu of and not in addition to the snow loading. However, unbalanced snow loads, sliding and drifting snow (in particular areas), or wind loads may be the controlling load case for particular elements. Reduction of roof live loads will not be allowed per IBC paragraph titled “Reduction in Live Loads.”

4.8.1.3 Horizontal Loads (Acting Inward and Outward).

4.8.1.3.1 The structural system wind design, including components and cladding, shall be in accordance with ASCE 7, and the seismic design shall be designed in accordance with the IBC or UFC 3-310-03A based on the following required design criteria.

a. Use the IBC for the seismic design for all structures except essential buildings. Use UFC 3-310-03A only for the seismic design of essential buildings and for bracing requirements of mechanical and electrical equipment.

[Editor’s Note. If subparagraph “b” is deleted because there is no pre-engineered metal building then move the text of subparagraph “a” back into the main paragraph and do not have a subparagraph “a.”]

b. Pre-engineered metal buildings shall be designed in accordance with ASCE 7 for wind and the IBC or UFC 3-310-03A for seismic. Use UFC 3-310-03A only for the seismic design of essential buildings and for bracing requirements of mechanical and electrical equipment.

4.8.1.3.2 **Seismic Spectral Accelerations.** Seismic Spectral Accelerations S_s and S_1 for each military installation and major city in which CESPA has been involved are listed in Table T2 below.

4.8.1.3.3 **Wind Criteria.** Wind criteria for each military installation and major city in which CESPA has been involved are listed in Table T2 below.

4.8.1.3.4 **Table T2.** Basic Wind Speeds, Seismic Spectral Response Accelerations, Ground Snow Loads, and Frost Penetration.

[Editor’s Note. In Table T2 for writing an RFP document edit out all but the location of the respective project.]

	(NOTE 1) BASIC WIND SPEED		(NOTE 2) SEISMIC SPECTRAL RESPONSE ACCELERATIONS		(NOTE 3) GROUND SNOW LOAD		FROST PENETRATION	
LOCATION	Km/hr	(MPH)	S_s g	S_1 g	N/m^2	(PSF)	mm	Inches
Cannon AFB, NM	145	90	0.119	0.037	720	15	457.2	18
Holloman AFB, NM	145*	90*	0.348	0.097	240	5	101.6	6
Kirtland AFB, NM	161	100	0.615	0.183	240	5	457.2	18
Kirtland AFB, NM South Sector	201	125	0.615	0.183	240	5	457.2	18
White Sands, NM	145	90	0.391	0.115	240	5	101.6	6

(main post only)								
Alamogordo, NM	145	90	0.351	0.099	240	5	101.6	6
Gallup, NM	145	90	0.297	0.066	480	10	1066.8	42
Las Cruces, NM	145	90	0.338	0.097	240	5	101.6	6
Santa Fe, NM	145	90	0.475	0.147	720	15	457.2	18
Abiquiu Dam, NM	145	90	0.609	0.190	720	15	457.2	18
Cochiti Dam, NM	145*	90*	0.610	0.192	720	15	457.2	18
Conchas Dam, NM	145	90	0.167	0.048	720	15	609.6	24
Cuchillo Dam, NM	145	90	0.303	0.089	480	10	457.2	18
Galisteo Dam, NM	145*	90*	0.473	0.139	720	15	457.2	18
Jemez Dam, NM	145	90	0.516	0.152	960	20	457.2	18
Santa Rosa Dam, NM	145	90	0.161	0.052	720	15	609.6	24
Two Rivers Dam, NM	145	90	0.115	0.039	480	10	609.6	6
Davis-Monthan AFB, AZ	145	90	0.327	0.088	240	0	0	0
Luke AFB, AZ	145	90	0.234	0.068	0	0	0	0
Chinle, AZ	145	90	0.215	0.055	480	10	1295.4	51
Douglas, AZ	145	90	0.400	0.108	240	0	0	0
Florence, AZ	145	90	0.321	0.088	240	0	0	0
Hunters Point, AZ	145	90	0.248	0.056	720	15	1066.8	42
Leupp, AZ	145	90	0.329	0.092	240	5	457.2	18
Tucson, AZ	145	90	0.327	0.088	240	0	0	0
Winslow, AZ	145	90	0.187	0.059	240	5	457.2	18
Yuma, AZ	145	90	0.764	0.262	0	0	0	0
Alpine, TX	145	90	0.331	0.090	240	0	152.4	6
El Paso, TX	145	90	0.363	0.108	480	5	152.4	6
Presidio, TX	145	90	0.322	0.090	240	0	152.4	6
Sierra Blanca, TX	145	90	0.411	0.131	240	5	152.4	6
Fort Irwin, CA	137	85	1.044	0.352	240	5	0	0
John Martin Dam, CO	145	90	0.123	0.042	958	20	914.4	36
Trinidad Dam, CO	145	90	0.199	0.062	958	20	812.8	32
Indian Springs, NV	145	90	0.511	0.153	240	5	0	0

Notes for Wind Speed, Seismic Spectral Response Accelerations, and Snow Load table:

(1) Site specific wind speeds are from ASCE 7 and UFC 3-310-01. Basic wind speed is 50-year recurrence interval, 3-second gust speed.

Design wind pressure should be determined using ASCE 7. (*) indicates special wind region.

(2) Seismic spectral response accelerations are based on mapped contours from the National Seismic Hazard Study conducted by the U.S. Geological Survey for the Federal Emergency Management Agency. S_s is Spectral Acceleration at 0.2 seconds. S_1 is Spectral Acceleration at 1.0 second.

(3) Ground snow loads are from ASCE 7 and UFC 3-310-1. Snow loads on roofs will be in accordance with ASCE 7 and UFC 3-310-1.

4.8.1.3.5 **Minimum Seismic Bracing Requirements for Equipment.**

a. Seismic Design Categories. Reference ASCE 7 for definition of seismic design categories A through F.

b. Bracing Not Required. Buildings containing equipment in the following seismic design categories do not require protection of the equipment from seismic events. Thus specification Section 13 48 00 - SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT, 13 48 01 - SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT and 26 05 48 - SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT are not required.

(1) Equipment in Seismic Design Categories A and B.

(2) Equipment in Seismic Design Category C when the importance factor is equal to 1.0.

(3) Equipment in Seismic Design Categories D, E, and F that are mounted at 4 feet or less above a floor level and weigh 400 lbs or less and are not critical to the continued operation of the building.

(4) Equipment in Seismic Design Categories C, D, E, and F weighing 20 lbs or less or distribution systems weighing 5 lb/ft or less.

c. Bracing Required. If the building seismic design criteria does not comply with the requirements of the above paragraph titled “Bracing Not Required” then the equipment has to be braced in accordance with the requirements of UFC 3-310-04, and the specification Sections 13 48 00 - SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT, 13 48 01 - SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT and 26 05 48 - SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT have to be edited for the project and included in the project specifications.

d. These requirements can be used for bracing details of medical equipment by editing the specifications accordingly.

4.9 **General Design Criteria.**

4.9.1 **Engineer-of-Record**. The Engineer-of-Record (EOR) for all aspects of structural designs, including connections, for in-house jobs shall be the Chief of the engineering office performing the design. The EOR for all aspects of structural designs, including connections, for Architect-Engineer or Engineer-Architect designs, shall be the principal-in-charge of the design firm. ETL 1110-3-447 sets a policy that for the design of structural steel (except for pre-engineered metal building systems), reinforced concrete, precast concrete framing and cladding including their connections (except precast lifting design), and masonry the project designer shall maintain complete design responsibility for members and connections. This responsibility is not transferable to the construction contractor. In a like manner UFC 3-310-07A and provisions of specification Section 05 40 00 require that the project designer has ultimate design responsibility for design of light gage cold-formed framing. [For pre-engineered metal building systems the design of the building structure will be considered an extension of the design of the EOR. All pre-engineered metal building components and their design shall be subject to the approval of the EOR.]

> [Editor’s Note. Delete the last two sentences if there is not a pre-engineered metal building on this project.]

4.9.2 **Serviceability.**

4.9.2.1 **Foundation Settlement**.

4.9.2.1.1 An adequate level of protection against structural failure due to uniform and/or differential foundation settlement shall be provided.

4.9.2.1.2 For additions to existing buildings <u>do not</u> support new floor or roof structures on any part of the existing building structure. The new building load on the existing structure could cause settlement of the existing structure and thus damage to the existing structure components.

4.9.2.2 **Vertical Deflection of Suspended Horizontal Framing Members**.

4.9.2.2.1 Vertical Deflections. Building serviceability shall not be impaired by vertical deflections.

4.9.2.2.2 Second Floor Structure Vibrations. Concrete on steel deck floor slab systems shall comply with the vibration criteria of SJI Technical Manual No.5, “VIBRATION of Steel Joist-Concrete Slab Floors” and for floor purlins and main support beams, AISC Design Guide 11, “Floor Vibration Due to Human Activity”. Provide structural floor vibration calculations as part of the structural calculations of the Design Analysis. For floor joists the human response domains shall be in the “slightly perceptible” range or stiffer. For floor purlins or main support beams the criteria in AISC Design Guide 11, “Floor Vibration Due to Human Activity” paragraph titled “Recommended Criteria for Structural Design” shall be followed.

4.9.2.2.3 Vertical deflections shall be limited to the following criteria.

a. L/240 for roofs live loads.
b. L/600 for masonry walls and lintels, and supports of masonry walls.
c. L/360 for floor live loads and L/240 for floor total loads.

4.9.2.3 **Pre-Engineered Metal Buildings.** Pre-engineered metal buildings vertical deflections shall comply with CESPA guide specification Section 13 34 19 – PRE-ENGINEERED METAL BUILDINGS, paragraph titled “Framing and Structural Members”.

[Editor’s Note. Delete this paragraph if there is no pre-engineered metal building on this project.]

4.9.2.4 **Horizontal Deflection (drift)**.

4.9.2.4.1 Horizontal drift shall not exceed the limits set forth in IBC, table titled “Allowable Story Drift” when the structure is subjected to the required seismic and wind criteria.

4.9.2.4.2 Pre-engineered metal building horizontal deflections shall comply with specification Section 13 34 19 – PRE-ENGINEERED METAL BUILDINGS, paragraph “Drift Provision.”

[Editor’s Note. Delete this paragraph if there is no pre-engineered metal building on this project.]

4.9.3 **Antiterrorist Precautions**. Antiterrorist precautions shall be taken into consideration for all DoD projects in accordance with the structural requirements of the UFC 4-010-01 – DoD Minimum Antiterrorism Standards for Buildings.

4.9.4 **Construction Tolerances**. Allowable variations from level, or specific slopes, shall be as follows:

4.9.4.1 For overall length of 10-feet or less plus or minus 1/8-inch.

4.9.4.2 For overall length of 20-feet or less plus or minus 1/4-inch.

4.9.4.3 For overall length of above 20-feet plus or minus 3/8-inch.

4.9.4.4 Determining flatness and levelness of the floor slab surfaces on-ground and on-deck shall be measured by the F-Number System in accordance with ASTM E 1155, Determining Floor Flatness and Levelness Using the F-Number System. The flatness and levelness tolerances shall meet the requirements for "Float Finish" and "Trowel Finish" only. For housing the F-Number shall be 25. No other tolerances will be allowed except for "Very Flat" if required by a specific function of the building. The requirements for the F-Number System shall be as specified in guide specification Section 03 31 00 – CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph titled "Floors by the F-Number System."

A flatness and levelness tolerance measured by the “Straightedge System” is not allowed.

4.9.5 **Durability - Time Reliability.**

4.9.5.1 Structural components shall be protected from condensed moisture that could impair their structural adequacy through deterioration.

4.9.5.2 Special attention shall be given to protection against corrosion or oxidation of metals, decay of wood and wood base materials, spalling of concrete, leaching of mortar, and deterioration of adhesives. Prevention of these hazards shall be especially important.

4.9.5.3 The materials used in structural elements, components, and assemblies shall be resistant to or protected from damage by exposure to normal climatic conditions.

4.9.6 **Manholes, Pullboxes, Surface Inlets, etc.** These structures should comply with the requirements of the Civil and Electrical disciplines. Concrete strength shall be a minimum 3000 psi. Precast concrete structures are acceptable and should be used where more economical. H10 design wheel loads will be used as a minimum except structures in pavement shall be designed for the pavement design wheel loads.

4.9.7 **Site Headwalls.** Dimensions of headwalls shall be determined from Civil requirements.

4.9.8 **Interior and Exterior Mechanical Equipment Foundation Pads.** Interior and Exterior foundation pads shall be shown on the contract drawings as specified in CESPA Standard Structural Drawing Sheet S001, Concrete and Foundation Notes.

4.9.9 **Pits.** All foundation pits shall have concrete floor slabs-on-ground. Pits shall be designed for buoyancy forces where they are placed within a water table. The pits can be fabricated as cast-in-place or precast concrete units. If the pit has a concrete top slab, the top slab shall be a removable precast concrete slab with lifting inserts. The top slab shall contain a minimum 24-inch diameter manhole cover and shall be design for H-10 wheel loading.

4.9.10 **Stoops, Ramps and Porches.** Small stoops, ramps and porches shall be soil-supported, turned-down-edge type slabs-on-ground and be slip-doweled to the building foundation. Reference the CESPA Standard Structural Drawing Sheet S001, Concrete and Foundation Notes.

4.9.11 **Retaining Walls and Other Earth Retaining Structures.** Guidance for the design of retaining structures is furnished in EM 1110-2-2502, Retaining and Flood Walls. Lateral earth loads on structures should be based on p = whk where p = lateral pressure, w = wet unit weight of earth 120 pcf minimum, may be higher in some areas, h = depth of soil and k = coefficient of lateral earth pressure which will be furnished in the FDA or by the Geotechnical Engineer. Surcharge loads should be included where applicable. In case of high ground water table, investigation should also be made for lateral buoyant earth pressure plus 100 percent hydrostatic pressure at one-third overstress. Where drains or weep holes are provided, the water table may be assumed to be lowered 50 percent of the difference in the water table and drain elevations. Hydrostatic uplift should also be included. Design retaining walls for the following criteria:

4.9.11.1 The resultant of the vertical and horizontal loads shall fall within the middle third of the base.

4.9.11.2 The bearing pressure shall not exceed the allowable bearing pressure.

4.9.11.3 The safety factor against overturning shall be at least 1.5.

4.9.11.4 The sliding safety factor shall be at least 1.5. Where a sloping backfill surface occurs, the Geotechnical Engineer should be contacted for adjustment of the design "K" lateral earth pressure factor. Use the working stress method of design with actual (un-factored) loads.

4.9.12 **Freestanding Exterior Garden Walls.** Freestanding exterior garden walls shall be designed to resist lateral wind per ASCE 7 and seismic forces per the IBC for the minimum requirements set forth in the above Table T2.

4.9.13 **Walls Mostly Below Grade**. Walls mostly below grade that are supported laterally by diaphragms at or near the top and bottom, shall be designed using loads based on at-rest soil pressures.

4.9.14 **Aircraft Hangar Wind Loads**. Aircraft hangars and maintenance buildings shall be designed to resist wind loads resulting from the basic wind speed set forth in the above Table T2 with aircraft access doors both open and closed.

4.9.15 **Monorail Design**. Hoist runway beams, their supporting members and lateral bracing shall be detailed by the structural EOR for the project. Beam design shall be conservative due to the possibility of overloads caused by misuse of the hoist.

4.9.15.1 Except as specified herein, the monorail beam design shall be in accordance with AISC design specifications taking into account the laterally unsupported length of the beam compression flange. The monorail beam vertical service live load shall be 1.5 times the rated capacity of the hoist to account for impact and overload, and a lateral load of 0.2 times the hoist rated capacity perpendicular to the beam. The beam shall be designed for the service live load plus dead load of beam and hoist. The vertical beam deflection to length ratio shall be limited to 1/800 with a service live load equal to the rated hoist capacity. A “W” or “S shape” beam with cap channel shall be used for all but very short spans.

4.9.15.2 The service live load for hangers supporting the monorail beam shall be 2.0 times the rated capacity of the hoist and a lateral load of 0.2 times the rated hoist capacity perpendicular to the beam. The hangers shall be designed for the service live load plus dead load of the beam and hoist. Monorail beams should be braced for longitudinal forces equal to 0.1 times the rated hoist capacity.

4.9.15.3 One load case for design of the building framing supporting the monorail shall be vertical service design load of 1.5 times the rated capacity of the hoist combined with all other live loads and dead loads supported by the framing. When the monorail is supported by roof framing, a service live load of 0.5 times the total roof design live load is appropriate for combining with the hoist service load of 1.5 times the hoist rated capacity. When building framing supporting the monorail is open web steel joists, the structural EOR shall designate KCS joists and provide a load diagram for custom design by the joist manufacturer. The design shall also assure proper joist loading due to the concentrated loads at the monorail hangers by requiring the hangers to be at the panel points, or adding special joist web or chord reinforcing when the hangers are not at the panel points.

4.9.16 **Traveling Crane Runway Girders.** Runway girders may be designed as simple or continuous members with certain limitations. Continuous girders should not be used where significant unequal foundation settlement is likely to occur. Where foundations are other than shale or hard rock, check anticipated differential settlement so that the difference is limited to 0.003 L between adjacent supports. Limit live load deflection to span length at mid-span to 1/800. The crane supporting structural members shall be designed to comply with ASCE 7, paragraph titled “Crane Loads”. For continuous girders limit ratio of length of adjacent spans to 2:1. Connect ends of simply supported girders in such a manner as to allow the ends to rotate under vertical loading. Use adjustable bolted connections for fastening the rail to the girder (welded connections are not permitted).

4.9.17 **Oil Storage Tanks.**

4.9.17.1 **Foundations.** Foundations for ground level oil storage tanks shall conform to the recommendations in the Foundation Design Analysis (FDA), tank manufacturer's recommendations, API 650, ”Welded Steel Tanks for Oil Storage”, and minimum requirements shown on CESPA Standard Structural Drawings Sheets T-1, T-2 and T-3. The width of reinforced concrete ring foundations for vertical tanks on ground shall be designed to support the load from the tank wall and roof plus weight of tank fluid directly above the ring without exceeding the allowable foundation bearing pressure. The ring circumferential reinforcement shall be designed for hoop tension caused by "at rest" lateral earth pressure acting on the inside of the ring, taking into account the surcharge from weight of fluid in the tank. When applicable, the ring shall be designed for stresses resulting from seismic forces combined with the other stresses.

4.9.17.2 **Wind Design.** Tanks shall be designed for wind loads in accordance with ASCE 7 for a required wind speed of the local area in accordance with the above Table T2, a minimum speed of 90 mph or in accordance with API - 650 whichever is the most severe condition.

4.9.17.3 **Seismic Design**. Tanks shall be designed for seismic loads in accordance with the IBC and the coefficients provided in the above Table T2 or API 650 whichever is the most severe condition.

4.9.18 **Water Storage Tanks**.

4.9.18.1 **Ground Level Tank Foundations.** The width of reinforced concrete ring foundations for vertical tanks on ground shall be designed to support the load from the tank wall and roof plus weight of tank fluid directly above the ring without exceeding the allowable foundation bearing pressure. The ring circumferential reinforcement shall be designed for hoop tension caused by "at rest" lateral earth pressure acting on the inside of the ring, taking into account the surcharge from weight of fluid in the tank. When applicable, the ring shall be designed for stresses resulting from seismic forces combined with the other stresses. The foundation design shall also be in compliance with the design criteria of AWWA D100 Chapter 12, Foundation Design.

4.9.18.2 **Elevated Tank Foundations.** Foundations shall be designed in accordance with the design criteria of AWWA D100 Chapter 12, Foundation Design, and the recommendations of the Foundation Design Analysis (FDA).

4.9.18.3 **Wind Design.** Tanks shall be designed for wind loads in accordance with ASCE 7 for a required wind speed of the local area in accordance with the above Table T2, a minimum wind speed of 90 mph or in accordance with AWWA D100 whichever is the most severe condition.

4.9.18.4 **Seismic Design**. Tanks shall be designed for seismic loads in accordance with the IBC using the coefficients provided in the Table T2 in this document or AWWA D100 whichever is the most severe condition.

4.9.19 **Reinforced Box Culverts**. Box culvert design shall conform to the requirements in AASHTO Standard Specifications for Highway Bridges. Appropriate State Highway Department standard designs that conform to AASHTO specifications may be used.

4.9.20 **Materials.**

4.9.20.1 **Concrete**.

4.9.20.1.1 **General**. All concrete shall have a minimum compressive strength of 3000 psi at 28 days. All foundation walls (stem and/or basement walls) and footings shall be constructed of reinforced cast-in-place concrete. All concrete structures shall be designed per ACI 318.

4.9.20.1.2 **Ready-Mix Concrete**. ASTM C 94.

a. All concrete shall contain an approved flyash. The minimum percent of flyash required shall be determined per specification Section - AGGREGATE FOR PORTLAND CEMENT CONCRETE.

b. Coarse and fine aggregates shall have less than 0.1% expansion when tested using ASTM 1260 modified to incorporate the cementitious portion of the concrete mix design. Reference specification Section– AGGREGATE FOR PORTLAND CEMENT CONCRETE.

4.9.20.2 **Testing**. Testing of concrete work shall be done at the contractors expense by an approved independent testing laboratory and be of the frequency as stated in the guide specifications Section 03 31 00 - CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph titled “Strength Specimens”.

4.9.20.3 **Forms**. Materials for forms shall be plywood, metal, metal-framed, aluminum, reinforced fiberglass, or plywood-faced to provide continuous, straight, smooth, exposed surfaces. Form classes of concrete shall be per specification Section 03 11 13 – STRUCTURAL CONCRETE FORMWORK, paragraph titled “FORM MATERIALS”. The classes of formed concrete finishes to be used on this project shall be edited as such in this paragraph and in specification Section 03 31 00 - CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph titled “Finishing Formed Surfaces”.

4.9.20.4 **Reinforcing Materials.** Reinforcing bars shall meet the minimum requirements of ASTM A 615, Grade 60, deformed. Ties and stirrups can be ASTM A 615, Grade 40 deformed.

4.9.20.5 **Concrete Materials**.

a. Cement. ASTM C 150, Type I-II Portland cement low alkali (0.6% or less).
b. Fine Aggregate. ASTM C 33.
c. Coarse Aggregate. ASTM C 33.
d. Air-Entraining Admixture. ASTM C 260.
e. Flowing Concrete Admixture. ASTM C 1017, Type 1 or 2.
f. Calcium Chloride will not be permitted.
g. Fly Ash. ASTM C 618, Class "F".

4.9.20.6 **Special Concrete Requirements**. To alleviate deterioration of concrete due to soil sulfate action at Holloman AFB, New Mexico and in the Tularosa Basin of New Mexico, the following requirements shall be applied for all concrete used at these locations.

a. coarse and fine aggregates shall be washed,
b. calcium chloride or admixtures containing chloride salts shall not be used,
c. shall contain Type V cement low alkali (0.6% or less),
d. shall have an air content by volume of 5.5 percent plus or minus 1.5 percent,
e. shall contain the minimum amount of fly ash required by specification Section – AGGREGATE SOURCES FOR PORTLAND CEMENT CONCRETE.

f. shall not exceed a slump of 3-inch,
g. shall be used for electrical systems (ducts, manholes, pull boxes, vaults, etc.) and
h. the use of recycled concrete is prohibited.

4.9.20.7 **Curing Concrete**. Concrete curing shall be as specified in the CESPA structural guide specifications Section 03 31 00 - CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph titled “Curing and Protection”.

4.9.20.8 **Capillary Water Barrier**. Provide 6-inch capillary water barrier under all concrete floor slabs-on-ground. Reference CESPA Standard Structural Drawing Sheet S001, “Concrete and Foundation Notes” for the capillary water barrier gradation requirements.

4.9.20.9 **Vapor Retarder**. A vapor retarder shall be placed under all concrete floor slabs-on-ground. The vapor retarder shall comply with ASTM E-1745, Class A, five ply, and nylon with a permeance rating less than 0.3 perms. Polyethylene membrane will not be allowed because it is easily susceptible to holes being punched through and tearing the membrane. A sand layer between the bottom of the floor slab-on-ground and the vapor retarder will NOT be allowed, no exceptions. The sand layer will retain moisture that will slowly permeate up through the slab and weaken the floor finish material adhesive thus releasing the floor finish material from the slab. The CESPA realizes that placing concrete directly on the vapor retarder makes finishing the slab more difficult due to the slower rate of drying of the slab, but that this requirement is essential to minimize outside the slab moisture from slowly entering the slab concrete.

4.9.20.10 **Precast Prestressed Concrete**. Reference the requirements of CESPA structural guide specification Section 03 45 01 - PRECAST ARCHITECTURAL CONCRETE unless noted otherwise in this document. Acceptance of precast units shall depend on, but not necessarily be limited to the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing.

4.9.20.11 **Post-Tensioned Concrete**. Reference the requirements of CESPA guide specification Section 03 36 50 - POST TENSION CONCRETE unless noted otherwise in this document.

4.9.20.12 **Masonry**.

4.9.20.12.1 For design of the masonry use a unit prism strength, F_m’=1500 psi.

4.9.20.12.2 Masonry units shall have a minimum 28 day compressive strength of 1900 psi on net area.

4.9.20.12.3 Grout fill shall be a minimum 2000 psi, pea gravel aggregate concrete.

4.9.20.12.4 All mortar and concrete masonry units shall contain a water repellant admixture. Integral water repellant shall be a liquid polymeric admixture.

4.9.20.13 **Structural Steel**.

a. Wide Flange Shapes: ASTM A 992.
b. Miscellaneous Shapes: ASTM A 36 or ASTM A 572 Grade 50.
c. Structural Tubing: ASTM A 500 Grade B.
d. Structural Pipe: ASTM A 53 Grade B.
e. Connection Bolts: ASTM A 325.
f. Anchor Bolts or Rods: ASTM A 307 or ASTM F 1554 respectively.

4.9.20.14 **Cold-Formed Steel Framing Members.** Reference the requirements of CESPA guide specification Section 05 40 00 - COLD-FORMED STEEL FRAMING and/or Section 04 21 13 - NONBEARING MASONRY VENEER/STEEL STUD WALLS unless noted otherwise in this criteria document.

4.9.21 **Diaphragms.** Diaphragms shall have continuous chord members on all edges and shall have direct positive connections for transferring load to all members of the main lateral force resisting system. The use of transferring lateral loads through joist seats is not acceptable.

4.9.22 **Gypsum Wallboard.** Gypsum wallboard shall not be used as a lateral resisting element of the building lateral support system.

4.10 **Foundation Design.**

4.10.1 **General**.

4.10.1.1 **Foundation System Type**. The recommended foundation type, allowable bearing pressure, foundation depth, expansive/settlement parameters, etc. will be included in the final Foundation Design Analysis (FDA) unless otherwise required in this document.

4.10.1.2 **Foundation Notes**. Foundation notes shall be included in the structural drawings as shown in CESPA Standard Structural Drawing Sheet S001, “Concrete and Foundation Notes”.

4.10.1.3 **Foundation and Slab-On-Ground Underlying Soil Moisture Control**. Controlling foundation moisture is critical for the success of the building foundation. A number of items should be considered for the control of water infiltration around the building perimeter. These items are as follows:

4.10.1.3.1 The structural designer should coordinate with the site designer and landscape designer on the importance of measures to control water near the perimeter of the building. All surface water flowing into the building site should be diverted around the structure so that it will not infiltrate the building foundation subgrade soils.

4.10.1.3.2 Water from rainfall should be prevented from entering the ground near the perimeter of the structure, by providing paving where adequate drainage slopes are not possible and diverting gutter downspouts away from the foundation.

4.10.1.3.3 Use interceptor or perimeter drains when surface or underground water cannot be diverted away from the building. Foundation drainage systems should be carefully designed to prevent them from introducing water into the building foundation subgrade soils.

4.10.1.3.4 Landscape plantings and irrigation systems should be planned so that watering of beds or lawns does not introduce water to the building foundation subgrade soils or, drying of the foundation does not occur due to withdrawal of soil moisture by roots from large plants near the building perimeter.

4.10.1.3.5 All floors slabs-on-ground subjected to water shall be sloped to drains to prevent water from entering the sub-grade soils through joints in the floors slabs-on-ground. All joints shall be sealed as specified on the joint details specified in the “Concrete and Foundation Notes” on the CESPA Standard Structural Drawing Sheet S001. All floor drains shall be pressure tested for leaks.

4.10.1.4 **Basements.** Basement floors will be concrete slabs-on-ground separated from the basement walls by a minimum 3/8-inch expansion joint material. Basement walls shall have membrane waterproofing on the outside and under the slab with a continuous perimeter drain around basement. The slab-on-ground vertical joint to the basement wall shall be waterproofed at the membrane under the slab. Basement walls shall be designed for lateral hydrostatic pressure as well as lateral soil pressure. In such cases, the perimeter drains are usually assumed to be 50 percent effective; i.e., the water table in soil against the wall is assumed to be located at one-half the difference between the site design water table elevation and the elevation of the wall drain. The CESPA can provide upon request typical basement wall details for the above criteria.

4.10.2 **Design Loads.** Allowable foundation bearing pressures are given in the FDA and will normally be given as "net" values; intended for use with service loads consisting of dead loads plus that portion of live loads that act continuously, usually 50-percent. Use of common live load reduction factors is one way to approximate the continuous live load. The "continuous live load" concept does not apply to certain foundations with high transient loads, such as crane loads, where the full live load should be considered in the foundation load. Since allowable bearing values are net values, do not include the weight of footings, piers or overburden in the design loads. Lateral forces may be present due to wind or seismic loads or due to rigid frame thrust. Such loads may require use of foundation ties. Ties for deep foundations may be necessary in seismic regions as required by the IBC.

4.10.3 **Floor Slabs-on-Ground Subjected to Vehicular Loading.** Where floor slabs-on-ground are subjected to vehicular loading, the floor slab-on-ground must be designed in accordance with reference UFC 3-320-06A. Aircraft hangar slabs-on-ground will be designed using aircraft pavement criteria. Slabs-on-ground subjected to vehicular loading should be designed using a minimum flexural strength of 650 psi. The

4.10.4 **“Floating” Slab-On-Ground Foundation System**. A floating floor slab-on-ground foundation system is discouraged by CESPA due to the susceptibility of the slab curling at the free edges. Slab curling is a common occurrence in the dry arid climate of New Mexico and Arizona. It is preferred by CESPA to use a “Monolithic Floor Slab-On-Ground with Continuous Turned-Down-Edge Footings, Integral Interior Continuous Footings, and Integral Spread (Spot) Footings System”, see the following paragraph titled “Monolithic Floor Slab-On-Ground with Continuous Turned-Down-Edge Footings, Integral Interior Continuous Footings, and Integral Spread (Spot) Footings System” for information on this type of foundation system.

4.10.4.1 **Continuous Footings**. The foundation continuous footings shall be reinforced concrete with a minimum thickness of 12-inches with a minimum 2-#4 bars continuous and minimum #4 bars at 48-inches on center transverse bottom reinforcement. The footing width shall be determined by design and shall be at least 8-inches wider than the foundation wall (minimum 4-inches on each side of the foundation wall).

4.10.4.2 **Column Spot Footings**.

4.10.4.2.1 Column spot footing sizes shall be determined by design but shall not be less than 24-inches in any direction and a minimum thickness of 12-inches. The spot footings shall be reinforced per design requirements with a minimum number and size of 3-#4 bars each way or 12-inches on center bottom reinforcement whichever provides the greater number of bars. Specify footing reinforcement by number of bars equally spaced and not by spacing.

4.10.4.2.2 Slab-on-ground blockouts for columns which bear below the top of the slab shall be detailed on the contract drawings as shown in CESPA Standard Structural Drawing Sheet S001, “Concrete and Foundation Notes”. The column base plate shall bear 8-inches below the top of the slab to the bottom of 2-inches of high strength non-shrink non-metallic grout under the base plate.

4.10.4.3 **Slabs-on-Ground**. Floor slabs-on-ground shall be a minimum of 5-inches thick, bar reinforced with a minimum #4 bars with a minimum area of reinforcing of 0.2% of the slab cross sectional area and located 1 1/2-inches clear from the top surface of the slab. The CESPA preference slab-on-ground reinforcing is #4 bars at 18-inches on center each way for a 5-inch thick slab-on-ground. Welded wire mesh and fiber mesh reinforcing in the slab concrete will not be allowed. There shall be a minimum 3/8-inch expansion joint material installed between the foundation walls and the slabs-on-ground. Reentrant corner bars with a minimum #4 bars by 36-inches long at 45 degrees to the main slab reinforcement shall be required as part of the slab reinforcement requirements.

4.10.4.3.1 **Slab-on-Ground Joints**. Slab-on-ground joints shall be located no greater than 25-feet on center each direction. The joints

4.10.4.3.2 **Early-Entry Dry-Cut (Soft Cut) Saw Cut Method.** Saw cut shall be performed as soon as the slab can support the weight of the operator and the machine without disturbing the finish (usually within 2 hours after final finishing time when the concrete's initial set stage is between 150 psi to 800 psi). The saw cut shall produce a joint of 1-inch minimum depth or depth recommended by saw-cut machine manufacturer. The saw cut machine shall have a depth control device to assure a constant-depth cut is maintained, and a means to prevent the raveling of concrete.

4.10.4.4 **Foundation Walls.** The foundation walls shall be a minimum 8 inches thick reinforced concrete. The walls shall be reinforced with a minimum #4 bars with a minimum vertical reinforcing area of 0.15 percent and a minimum horizontal reinforcing area of 0.25 percent of the wall cross sectional area. Provide continuous perimeter rigid insulation on the interior surface of the exterior foundation walls adjacent to all heated areas. The insulation shall provide an R-Value of 4 and be 24 inches deep or to the top of the footing; whichever is the least, from the top of the slab-on-ground. The minimum depth of the foundation wall from the top of footing to the top of the slab-on-ground shall be 18-inches.

4.10.5 **Monolithic Floor Slab-On-Ground with Continuous Turned-Down-Edge Footings, Integral Interior Continuous Footings, and Integral Spread (Spot) Footings System.** This foundation system shall consist of integral turned-down-edge footings under all exterior walls and interior ribs for all interior shear and load-bearing walls. The length of the interior ribs under interior shear and load-bearing walls shall be the same length as the wall plus 6-inches on each end of the respective wall. For typical required drawings of this type of foundation system reference CESPA Standard Structural Drawings Sheet RM4 and RM5. For the following descriptions reference the drawings on Sheet RM4 and RM5.

4.10.5.1 **Depth of the Turned-Down-Edge.** The depth of the exterior turned-down-edge footings shall be a minimum of 30-inches deep, at least 12-inches below the exterior finish grade or below the frost depth, whichever is greater. The depth of the interior footings shall be the same depth as the exterior turned-down-edge footings. These requirements will supersede any requirements in the FDA that are in conflict with these requirements.

4.10.5.2 **Width of the Respective Turned-Down-Edge or Rib Footing.** The width of the respective turned-down-edge or rib footing shall be a minimum of 12-inches or the required design width for the footing based on the allowable soil bearing pressure.

4.10.5.3 **Continuous Footing Reinforcing.**

4.10.5.3.1 Continuous footings shall be reinforced concrete with a minimum 2-#4 bars continuous and minimum #4 bars at 48-inches on center transverse bottom reinforcement. If the width of the footing is 18” or wider a minimum 3-#4 continuous bars shall be placed in the bottom of the footings.

4.10.5.3.2 Minimum size #4 dowels spaced at a maximum spacing of 12-inches on center shall connect the exterior and interior footings to the floor slab-on-ground.

a. For exterior footings the dowel horizontal leg shall be a minimum of 36-inches long placed on top of the slab reinforcing. The vertical leg shall project down to and cross the bottom footing reinforcing. The vertical leg of the dowel shall be placed with 2-inches of concrete cover on the exterior face of the footing and be wire tied to the side of the outer continuous bottom footing bar.

b. For interior footings, the dowel horizontal leg shall be a minimum of 12-inches long placed on top of the slab reinforcing. The vertical leg shall project down to and cross any one of the footing continuous reinforcing bars. The dowel does not have to be in the center of the footing width. The vertical leg of the dowel shall be wire tied to the side of the footing continuous bottom bar.

4.10.5.3.3 On the exterior face of the turned-down-edge footings provide a minimum of 2 - #4 continuous horizontal bars evenly spaced for the depth of the footings or at 10-inches on center whichever provides the greater number of bars. These horizontal bars shall be located 1-1/2 inches clear from the exterior face of the footing and be wire tied to the outside face of the vertical legs of the vertical dowels.

4.10.5.4 **Column Spot Footings**.

4.10.5.4.1 Column spot footing sizes shall be determined by design but shall not be less than 24-inches in each direction. The spot footings shall be placed integrally with the floor slab-on-ground and be the same depth as the adjacent exterior turned-down-edge or interior rib footings. The spot footings shall be reinforced per design requirements with a minimum of 3-#4 bars each way evenly spaced in the bottom of the footing and be tied to the slab-on-ground with 4-#4 vertical dowels in each corner of the footing. The dowels shall have a minimum 6-inch hook into the floor slab-on-ground. The vertical leg of the dowel shall be placed with 2-inches of concrete cover on the face of the footing and be wire tied to the side of the bottom footing bars. Specify the footing reinforcement by the number of bars equally spaced and not by spacing.

4.10.5.4.2 Slab-on-ground blockouts for columns which bear below the top of the slab shall be detailed on the contract drawings as shown in CESPA Standard Structural Drawing Sheet S001, “Concrete and Foundation Notes”. The column base plate shall bear 8-inches below the top of the slab to the bottom of 2-inches of high strength non-shrink non-metallic grout under the base plate.

4.10.5.4.3 **Slabs-on-Ground**. Floor slabs-on-ground shall be a minimum of 5-inches thick, unless noted otherwise, bar reinforced with a minimum #4 bar with a minimum area of reinforcing of 0.2% of the slab cross sectional area and located 1-1/2-inches clear from the top surface of the slab. The CESPA preference slab-on-ground reinforcing is #4 bars at 18-inches on center for a 5-inch thick slab-on-ground. Welded wire mesh and fiber mesh reinforcing in the slab concrete will not be allowed. Reentrant corner bars with a minimum #4 bars by 36-inches long at 45 degrees to the main slab reinforcement shall be required as part of the slab reinforcement requirements.

4.10.5.4.4 **Slab-on-Ground Joints**. Slab-on-ground joints shall be located no greater than 25-feet on center each direction. A slab panel bounded by the joints shall not exceed a ratio of 2 to 1. The joints can be either construction or contraction joints (weakened plane joints) as detailed in CESPA Standard Structural Drawing Sheet S001, "Concrete and Foundation Notes". Only saw cut joints performed by the early-entry dry-cut (soft cut) saw-cut method will be acceptable.

4.10.5.4.5 **Early-Entry Dry-Cut (Soft Cut) Saw Cut Method**. Saw cut shall be performed as soon as the slab can support the weight of the operator and the machine without disturbing the finish (usually within 2 hours after final finishing time when the concrete's initial set stage is between 150 psi to 800 psi). Saw cut shall produce a joint of 1-inch minimum depth or depth recommended by saw-cut machine manufacturer which ever is the deepest. The saw cut machine shall have a depth control device to assure a constant-depth cut is maintained, and a means to prevent the raveling of concrete.

4.10.6 **Reinforced Ribbed Mat Slab (RRMS) Foundation**.

4.10.6.1 **Definition**. RRMS foundations consist of a slab-on-ground that acts monolithically with a grid of stiffening beams (ribs) beneath the slab.

4.10.6.2 **General**. Ribbed mat slabs for non-expansive soil conditions shall be designed in accordance with reference UFC 3-320-02A. A RRMS foundation is usually used for very loose or highly expansive soil conditions. The restraint from the ribs below the slab-on-ground and the fact that the slab reinforcing has to be continuous through the slab joints for the foundation system to function as a mat slab creates numerous undesirable random cracking in the slab surface. Because of these unsightly cracks the use of RRMS is highly discouraged by the CESPA. If a RRMS foundation is recommended in the FDA it is required that a post-tensioned system be used to minimize slab cracking.

4.10.7 **Uniform Thickness Post-Tensioned Concrete Slab Mat Foundation System.**

4.10.7.1 **General**.

4.10.7.1.1 This type of foundation system can be used for both expansive soils and soft and loose soils. This foundation system shall consist of integral turned-down-edge footings under all exterior walls, 12-inches wide by 12-inches deep thickened slabs under all interior shear and load-bearing walls and 24-inches square and 12-inches deep thickened slabs under all interior column spot footings.

4.10.7.1.2 Another type of foundation system that can be used for expansive soils is described in the following paragraph titled “Pier-Grade Beam-Slab-On-Ground Foundation System in Expansive Soils”.

4.10.7.2 **Description**. This foundation system consists of a uniform thickness slab that is usually thicker than a normal slab-on-ground slab depending on the footprint dimensions of the foundation. The thickness of the slab is determined based on recommendations of the PCI manual titled Design and Construction of Post-Tensioned Slabs-on-Ground, paragraph titled “Uniform Thickness Foundations” where a ribbed mat foundation design is converted to a uniform thickness mat slab foundation using a conversion formula.

4.10.7.3 This foundation system shall consist of integral turned-down-edge footings under all exterior walls, 12-inch wide X 12-inch deep thickened slabs under all interior shear and load-bearing walls and a minimum 24-inch square and 12-inch deep thickened slabs under all interior column spot footings.

4.10.7.4 **Design Requirements**.

4.10.7.4.1 The design procedure involves satisfying minimum requirements of this document and performing a design analysis in accordance with PCI manual Design and Construction of Post-Tensioned Slabs-on-Ground.

4.10.7.4.2 The footprint of the foundation system shall be divided into overlapping rectangles as required in the PCI manual Design and Construction of Post-Tensioned Slabs-on-Ground paragraph titled “Structural Design Procedure for Slabs on Expansive Soils”.

4.10.7.4.3 In expansive soil areas, existing surface materials may be removed and replaced with compacted non-expansive fill to decrease the foundation soils swell potential. The depth of non-expansive fill required is site dependent and is normally based on the expansive intensity that is usually higher near the surface. The depth of fill shall be as required by the FDA.

4.10.7.5 **Minimum Requirements**.

4.10.7.5.1 The equivalent thickness of the uniform slab shall be as determined by Equation 33 of the PCI manual Design and Construction of Post-Tensioned Slabs-on-Ground or 7-1/2-inches whichever is the greater thickness.

4.10.7.5.2 Minimum 28-day concrete compressive strength shall be 3000 psi.

4.10.7.5.3 Floor slabs-on-ground need not be reinforced with conventional bar reinforcing unless noted otherwise.

4.10.7.5.4 Reentrant corner bars with a minimum #4 bars by 36-inches long at 45 degrees to the main slab reinforcement shall be required as part of the slab reinforcement requirements.

4.10.7.5.5 **Depth of the Integral Turned-Down-Edge Exterior Footing**. The depth of the integral exterior turned-down-edge footings shall be a minimum of 30-inches deep, at least 12-inches below the exterior finish grade or below the frost depth, whichever is greater. These requirements will supersede any requirements in the FDA that are in conflict with these requirements.

4.10.7.5.6 **Width of the Respective Integral Turned-Down-Edge Exterior Footings**. The width of the respective integral turned-down-edge exterior footing shall be a minimum of 12-inches or the required design width for the footing based on the design loads and the allowable soil bearing pressure.

4.10.7.5.7 All interior shear, load-bearing and non-load bearing walls shall be supported on 12-inch deep or the thickness of the slab-on-ground, whichever is the greatest thickness and 12-inch wide thickened slabs. This slab-on-ground thickness is needed for the anchorage of the vertical wall dowels for vertical wall reinforcing.

4.10.7.6 **Minimum Footing Reinforcement Requirements**.

4.10.7.6.1 The footings shall be reinforced concrete with a minimum 2-#4 bars continuous and minimum #4 bars at 48-inches on center transverse bottom reinforcement. If the width of the footing is 18-inches or wider a minimum 3-#4 continuous bars shall placed in the bottom of the footings.

4.10.7.6.2 A minimum #4 dowel spaced at a maximum spacing of 24-inches on center shall connect the exterior to the floor slab-on-ground. For exterior footings the dowel horizontal leg shall be a minimum of 36-inches long placed on top of the slab reinforcing. The vertical leg shall project down to and cross the bottom footing reinforcing. The vertical leg of the dowel shall be placed with 2-inches of concrete cover on the exterior face of the footing and be wire tied to the side of the outer continuous bottom footing bar.

4.10.7.6.3 On the exterior face of the turned-down-edge footings provide a minimum of 2 - #4 continuous horizontal bars evenly spaced for the depth of the footings or at 10-inches on center whichever provides the greater number of bars. These horizontal bars shall be located 1 1/2-inches clear from the exterior face of the footing and be wire tied to the outside face of the vertical legs of the vertical dowels.

4.10.7.7 **Slab-on-Ground Joints**. Slab-on-ground joints shall be located no greater than 20-feet on center each direction. A slab panel bounded by the joints shall not exceed a ratio of 2 to 1. The joints can be either construction or contraction joints (weakened plane joints) as detailed in CESPA Standard Structural Drawing Sheet S001, “Concrete and Foundation Notes”. Only saw cut joints performed by the early-entry dry-cut (soft cut) saw-cut method will be acceptable.

4.10.7.8 **Early-Entry Dry-Cut (Soft Cut) Saw Cut Method**. Saw cut shall be performed as soon as the slab can support the weight of the operator and the machine without disturbing the finish (usually within 2 hours after final finishing time when the concrete’s initial set stage is between 150 psi to 800 psi). Saw cut shall produce a joint of 1-inch minimum depth or depth recommended by saw-cut machine manufacturer which ever is the deepest. The saw cut machine shall have a depth control device to assure a constant-depth cut is maintained, and a means to prevent the raveling of concrete.

4.10.8 **Pier-Grade Beam Slab-on-Ground Foundation System in Expansive Soils**.

4.10.8.1 **General**. This type of foundation system shall be used only for expansive soil conditions. For soft or loose soil conditions use the foundation system type as described in the previous paragraph titled “Uniform Thickness Post-Tensioned Concrete Slab Mat Foundation System”. This requirement may be in conflict with the project FDA in which case a compromise will have to be reached with the Geotechnical Engineer that produced the FDA.

4.10.8.2 **Structural Grade Beam Design**. The grade beams shall be designed per ACI 318 requirements.

4.10.8.3 **Expansion Joint**. A continuous minimum 3/8-inch wide expansion joint shall be placed in the slab-on-ground at the intersection of all vertical surfaces.

4.10.8.4 **Void Forms and Retainers.** A 6-inch high carton formed voids with void retainers will be required under all structural grade beams.

4.10.8.5 **Masonry Walls**. Masonry walls, including masonry partitions, within the structure shall be placed on structural grade beams (including 4 inch walls) in order to reduce wall cracking problems due to soil movements.

4.10.8.6 **Soil Retaining Exterior Grade Beams**. In buildings with slabs-on-ground floors where the finished floor is more than 24-inches above outside grade, special attention shall be given to design of exterior grade beams to withstand lateral soil pressure from the fill under the floor slabs-on-ground.

4.10.8.7 **Drilled Pier Design**.

4.10.8.7.1 **General**. The piers shall be designed as short, tied columns with minimum vertical reinforcement per ACI requirements. Note that since pier shaft diameters are often larger for Geotechnical reasons than required for structural loads, the provisions of ACI 318 that allow a reduced concrete area to determine reinforcement may apply. This document shall govern for any conflicts that may occur with the requirement for the piers between the FDA and this document.

4.10.8.7.2 **Piers Through Expansive Soils**. Piers that extend through expansive soils may be subjected to tension loads caused by soil friction on the shaft as the soil expands. The FDA will give either recommended pier design tension or minimum shaft tension reinforcement and minimum bell size to anchor the pier when expansive soils cause pier tension. Pier tension reinforcing should be sized for net load obtained by subtracting the pier load due to the building dead weight from the tension due to soil heave.

4.10.8.7.3 **Pier Diameters**. Minimum pier diameters are 18 inches for piers up to 40 feet in depth and 24 inches for piers deeper than 40 feet.

4.10.8.7.4 **Bell Sizes**. Bell diameters should be specified in increments of 6 inches. Size bells for dead load plus the portion of live load that acts continuously.

4.10.8.7.5 **Pier Loads**. Pier loads should be computed only to grade (weight of pier, bell and earth above base of footing will be taken into account in determining "net" allowable bearing pressure given in FDA).

4.10.8.8 **Floor Slab-on-Ground and Grade Beams**.

4.10.8.8.1 The floor slab-on-ground shall consist of integral turned-down-edge structural grade beams under all exterior walls and all interior shear and load-bearing walls. The length of the interior grade beams under interior shear and load-bearing walls shall be the same as the wall length plus 6-inches on each end of the respective wall. For similar typical required drawings of this type of foundation system reference CESPA Standard Structural Drawings Sheet RM2.

4.10.8.8.2 **Depth of the Turned-Down-Edge grade Beams**. The depth of the exterior turned-down-edge grade beam shall be a minimum of 30-inches deep, the bottom at least 12-inches below the exterior finish grade or below the frost depth or as required by flexural design, whichever is greater. The minimum depth requirements of the interior footings shall be as for the exterior turned-down-edge grade beams. These requirements will supersede any requirements in the FDA that are in conflict with these requirements.

4.10.8.8.3 **Width of the Respective Turned-Down-Edge Grade Beams**. The width of the respective turned-down-edge grade beams shall be a minimum of 8-inches or the required design width.

4.10.8.9 **Lateral Loads on Grade Beams and Piers**. Design of Grade Beams and Drilled Piers Carrying Lateral Loads. The lateral force resisting system includes the structural system that transfers loads to the earth foundation. A system that ties the foundation elements together is highly desirable. Designers must be cognizant of the fact that seismic lateral forces computed by the Equivalent Static Force

Method are lower than the peak dynamic force. Appropriate soil safety factors must be applied to limit lateral deflections of foundation elements and to compute structural stresses in piers and grade beams. The structural designer should see the FDA and/or consult with the geotechnical engineer for recommended lateral soil design parameters.

4.10.8.10 **Slabs-on-Ground**.

4.10.8.10.1 Floor slabs-on-ground shall be a minimum of 5-inches thick, bar reinforced with a minimum #4 bar with a minimum area of reinforcing of 0.2% of the slab cross sectional area and located 1-1/2-inches clear from the top surface of the slab. The CESPA preference slab-on-ground reinforcing is #4 bars at 18-inches on center for a 5-inch thick slab-on-ground. Welded wire mesh and fiber mesh reinforcing in the slab-on-ground concrete will not be allowed.

4.10.8.10.2 The slabs-on-ground shall be thickened at the exterior and interior grade beams. The slab shall be minimum 8-inches thick at the grade beam and tapered up to the normal slab thickness for a distance of 48-inches back from the face of the grade beam. In the case of an interior grade beam a tapered slab shall project both directions from the face of the grade beam.

4.10.8.10.3 Reentrant corner bars with a minimum #4 bars by 36-inches long at 45 degrees to the main slab reinforcement shall be required as part of the slab reinforcement requirements.

4.10.8.11 **Slab-on-Ground Joints**. Slab-on-ground joints shall be located no greater than 25-feet on center each direction. A slab panel bounded by the joints shall not exceed a ratio of 2 to 1. The joints can be either construction or contraction joints (weakened plane joints) as detailed in CESPA Standard Structural Drawing Sheet S001, “Concrete and Foundation Notes”. Only saw cut joints performed by the early-entry dry-cut (soft cut) saw-cut method will be acceptable.

4.10.8.12 **Early-Entry Dry-Cut (Soft Cut) Saw Cut Method**. Saw cuts shall be performed as soon as the slab can support the weight of the operator and the machine without disturbing the finish (usually within 2 hours after final finishing time when the concrete’s initial set stage is between 150 psi to 800 psi). Saw cut shall produce a joint of 1-inch minimum depth or depth recommended by saw-cut machine manufacturer which ever is deepest. The saw cut machine shall have a depth control device to assure a constant-depth cut is maintained, and a means to prevent the raveling of concrete.

4.10.8.12.1 **Column Blockouts.** Slab-on-ground blockouts for columns which bear below the top of the slab shall be detailed on the contract drawings as shown in CESPA Standard Structural Drawing Sheet S001, “Concrete and Foundation Notes”. The column base plate shall bear 8-inches below the top of the slab to the bottom of 2-inches of high strength non-shrink non-metallic grout under the base plate.
4.10.8.13

4.11 **Superstructure System.**

4.11.1 **General.**

4.11.1.1 The system shall provide vertical and lateral load carrying capacity and shall provide durability, maintainability and cost effectiveness.

4.11.1.2 Roof openings and all supports for ventilators, fuel tanks, electrical bus ducts, unit heaters and other mechanical equipment must be detailed or adequately described on the drawings or in the specifications. The structural designer shall ensure that all mechanical and electrical equipment is properly supported and that architectural features are adequately framed and connected, especially where seismic design is required.

4.11.2 **Precast/Prestessed Concrete Hollow Core Plank Floors and Roofs.**

4.11.2.1 **General.** All design, detailing and tolerances of hollow core floor and roof (optional) planks (referred to as “plank(s)” in the rest of this document) shall be as recommended in the Manual for the Design of Hollow Core Slabs unless noted otherwise in this document.

4.11.2.2 **Plank Concrete.** Plank concrete shall be a minimum 28 day compressive strength of 4000 psi.

4.11.2.3 **Plank Sizes.** All planks shall be a maximum of 48-inches wide and minimum 8-inches thick. Reference CESPA standard drawing sheet HC-1.

4.11.2.4 **Diaphragm Chord Reinforcing.** All diaphragm chord reinforcing shall consist of a minimum 1-#4 continuous bar encased in the wall concrete grout space at the level of the planks.

4.11.2.5 **Grout.**

4.11.2.5.1 All grout used to bond the plank integral with each other in the shear keys shall have a minimum 28 day compressive strength of 3000 psi and shall be a sand aggregate non-shrink grout.

4.11.2.5.2 All grout used to bond the plank integrally with the supporting masonry; concrete walls or steel support beams shall have a minimum 28 day compressive strength of 3000 psi and shall be pea gravel aggregate non-shrink grout.

4.11.2.6 **Shear Key Reinforcing.** The grouted shear keys between the planks shall be reinforced with 1-#4 x 4’-0” dowel with a 12” hook at each bearing end of the plank. The 48” length shall be placed in the shear key between the plank and the 12” hook shall be placed horizontally in the wall grout space containing the diaphragm chord reinforcing. Reference HC-1.

4.11.2.7 **Grout Ends of Plank.** At least 12” of each hollow core in the planks shall be grouted solid with concrete grout at all bearing points and at each end of the planks to compensate for vertical shear forces. Reference HC-1.

4.11.2.8 **Topping Slab**. All floor planks shall be covered with a minimum 2 1/2" thick pea gravel aggregate concrete topping slab. The topping slab concrete shall have a minimum 28 day compressive strength of 3000 psi and shall be reinforced with welded wire fabric, supplied only in flat sheets, or with polypropylene fiber mesh reinforcing (steel fibers are not allowed).

4.11.2.9 **Plastic Bearing Plates**. All planks shall bear on a continuous 1/8" by 3" wide plastic bearing strip on the respective bearing material. Reference HC-1.

4.11.2.10 **Roof Plank**. If planks are used for the roof structure, the planks shall span in a direction perpendicular to the roof slope. The first plank shall be positively anchored to the supporting structure such that it will support the planks above it from sliding down due to the roof slope during erection.

4.11.3 **Structural Steel Framing**.

4.11.3.1 **General**. The structural system shall be designed for both the vertical and horizontal loads required by ASCE 7 and the IBC or UFC 3-310-03A, but not less than any dead loads and live loads specified in this document. Structural calculations shall be submitted for all vertical and horizontal designs.

4.11.3.2 **Superstructure Structural Steel notes**. Provide superstructure structural steel notes on the contract drawings as shown in CESPA Standard Structural Drawing Sheet S003, "General Structural Steel Notes".

4.11.3.3 **AISC Certification**.

4.11.3.3.1 The fabricating plant shall be certified under the AISC quality certification program for Category Sbd, Sbr, Cbd, Cbr structural steelwork. Edit the specification Section 05 12 00 - STRUCTURAL STEEL, paragraph "FABRICATION". Small projects under a project amount (PA) of $1,000,000 do not need the structural steel to be fabricated by a certified fabrication plant.

4.11.3.3.2 For pre-engineered metal buildings the fabricating plant shall be certified under the AISC quality certification program for Category MB structural steelwork, no matter the PA amount.

> [Editor's Note. Delete this paragraph if there is no pre-engineered metal building on this project.]

4.11.3.4 **Steel Frame Design**. Steel frame design will be in accordance with Manual of Steel Construction and the IBC or UFC 3-310-03A. Frame drift must be limited as necessary to prevent damage to supported wall systems and brittle cladding materials.

4.11.3.5 **Structural Steel Connections.** When seismic controls the design of the main frame, fully restrained moment connections shall comply with requirements of the IBC or UFC 3-310-03A. Connection design shall be in accordance with Manual of Steel Construction and shall be 100% designed and detailed. It will be acceptable to use the connection tables in the Manual of Steel Construction for design of the connections if applicable. If standard Manual of Steel Construction tables are used for the connection designs then these connections shall be specified on the drawings through the use of connection tables. It will not be acceptable for the structural designer to provide the connection loadings on the drawings and have the steel fabricator design and detail the connections. Structural calculations shall be submitted for all structural steel framing and connection designs. The reason for this is that the Corps of Engineers field personnel may be the reviewing individuals of the structural steel shop drawing submittals and the Engineer of Record may not see the submittals. The COE field personnel are usually not qualified to review connections other than those specified in the construction documents. Therefore, if the structural steel connections are 100% designed and detailed in the contract documents by the Engineer of Record there is not a chance that an unqualified person will be reviewing the design calculations of the connections.

4.11.3.6 **Framing System.** The framing system shall utilize braced (preferable) or moment resistant frames to carry lateral loads imposed on the system by wind and seismic forces.

4.11.3.6.1 If moment resistant frames are utilized they should consist of a combination of columns that are rigidly connected to the beams with moment connections and columns with simple beam to column connections, if possible. This is because of the high cost of using moment resistant connections at every beam to column connection.

4.11.3.6.2 For the frame design, assume the columns of both braced and moment resistant frames to be pin-connected at the foundation, if possible. The gravity only columns of both braced and rigid frames may be designed for an effective length equal to their actual length, i.e. K = 1. Design of the columns with rigid connections to beams shall include second order effects. Second order effects consist of member effects and structure effects.

4.11.3.6.3 For one-story steel frame buildings bar joists or joist girders may be used in moment-resisting frames by extending the lower chord and attaching it to columns. The bottom chord connection will not be made until all of the roof dead load is in place. Calculations must be included in the design analysis to demonstrate adequacy of such construction.

4.11.3.7 **Hip and Valley Framing**. Use light wide flange shape purlins with shear plate bolted connections when framing into hip or valley beams. Do not use steel open web bar joists where the flat bearing seats have to be shimmed on the hip or valley beams.

4.11.3.8 **Steel Column Base Plates**. All steel column base plates shall have a minimum four bolt pattern with leveling nuts on the anchor bolts and a minimum 2-inches thickness of non-shrink high-strength non-metallic grout under the base plates.

4.11.3.9 **Steel Beams Bearing on Masonry or Concrete Walls**. All main supporting steel beams that rest on masonry or concrete walls, pilasters or columns shall bear on expansion connections unless the steel beam is a drag strut or a roof purlin. The expansion connections shall consist of steel backed Teflon bearing pads attached to the beam and to the steel bearing plate respectively. Reference CESPA Standard Structural Sheet S005, “Steel Beam Slide Bearing Plate Detail” for a required detail of this expansion connection.

4.11.3.10 **Steel Trusses**. Trusses shall be designed with web member arrangement such that members are symmetrically loaded in the plane of the truss.

4.11.3.11 **Concrete Floor Slab on Steel Deck**.

4.11.3.11.1 Open web joist or wide flange steel purlins designed either composite or non-composite shall support the concrete floor slab on steel deck.

4.11.3.11.2 The concrete floor slab shall be comprised of a minimum 3.5-inches constant thickness normal weight concrete (lightweight concrete is not allowed) above the steel form deck. The weight of normal weight concrete is usually needed to dampen the floor system for vibrations. A slab thickness greater than 3.5-inches may be required for the vibration dampening requirements of the floor structure.

4.11.3.11.3 The concrete floor slab shall be jointed with slip-doweled contraction (weakened plane) and/or slip-doweled construction joints at a maximum spacing of 25-feet on center each direction. The exact locations of the slab joints shall be specified on a floor slab joint plan and shall be a separate plan from the floor framing plan. Only saw cut joints performed by the “early-entry dry-cut (soft cut) saw cut method” will be allowed for slab saw cut joints. Reference to the paragraph “Early-Entry Dry-Cut (Soft Cut) Saw Cut Method.” Provide joint details on the contract drawings for these slab joints. Reference the joint details specified on the CESPA Standard Structural Drawing Sheet S005 “Concrete Slab on Steel Deck Contraction Joint Detail” and “Concrete Slab on Steel Deck Construction Joint Detail”.

4.11.3.11.4 The slab shall be reinforced with a minimum 0.18 percent reinforcing in each direction. The reinforcing shall be minimum #3 bar reinforcement at a maximum spacing of 17-inches on center. Welded wire fabric and fiber mesh reinforcing in the concrete floor slab will not be allowed.

4.11.3.11.5 The steel form deck shall be a composite wide ribbed deck with a minimum 22 gage thickness and be not less than 1 1/2" deep, galvanized. The steel floor deck shall be designed per SDI specifications. All deck shall be fastened to the main supporting members with a minimum 5/8-inch diameter fusion welds, or power actuated or pneumatic fasteners spaced per the design requirements, but not less than 3 welds or fasteners per sheet width of deck. Weld washers shall not be used for the welded connections. Self-tapping screws will not be allowed for deck fastening to the main supporting members without CESPA prior approval. Only self-tapping screws and button punching performed by a pneumatic machine that punches through the deck ribs will be allowed to be used for the sidelap attachment of the steel deck. Button punching that uses a tool that only crimps the deck panels together will not be allowed. The steel deck can have nested or interlocking side laps. Interlocking sidelap decking using a self-tapping screw side lap attachment is not allowed unless the deck has a minimum 1/2” horizontal extension past the interlock rise of the deck to take a self-tapping screw.

4.11.3.11.6 The concrete floor slab system shall be used as a diaphragm to transmit lateral forces to masonry or concrete walls and/or structural steel building frames. Design of diaphragms is covered in the following paragraph titled "Lateral Shear Diaphragm Design".

4.11.3.11.7 For serviceability issues related to concrete floor slabs on steel deck see the paragraph titled “Serviceability” sub-paragraph titled “Second Floor Structure Vibrations”.

4.11.3.12 **Structural Steel Roof Framing**.

4.11.3.12.1 **General**. See the Architectural requirements for roof slope pitch(es), sound attenuation and any other criteria not covered below.

4.11.3.12.2 Flat Roofs - built-up roofing or single ply membrane roof systems. The most commonly used low-slope roof system consists of built-up roofing or single ply roofing over rigid insulation over steel roof decking supported by steel bar joists. Where sound attenuation is a design requirement or where a rigid diaphragm is needed concrete may be placed over the steel deck. A minimum slope of 1/4” to 12” shall be provided for drainage. It is typically more economical to build this slope into the framing rather than using rigid tapered insulation.

4.11.3.12.3 **Pitched Roofs**.

a. Asphalt shingles. Asphalt shingles, which are commonly used for roof slopes greater than 3 on 12, require a nailable deck for support. Since most military construction must be "protected, non-combustible" or "unprotected non-combustible", plywood decking or other types of wood decking are not usually used. Gypsum planks and so-called "nailable concrete" planks can be used for this purpose.

b. Standing Seam Metal Roof System (SSMRS). SSMRS is composed of metal roof panels supported and attached by clips fastened to secondary light gage purlins that are attached to the roof supporting joists or purlins. Rigid insulation is usually placed on the metal deck in between the secondary purlins. The metal roof panels will span between the light gage purlins to carry dead, live, concentrated and wind loads without additional support from other substrates that may be part of the roofing system.

(1) Experience has shown that improperly designed, specified or installed metal roof systems have failed due to panel buckling, panel sidelap seams (ribs) opening, anchor clips fracturing and fastener pull out, all due to wind uplift. The roof framing system must be designed and detailed to show necessary structural framing members to accommodate concealed anchor clip spacing. Roof panel clip attachments to underlying structural metal deck are not permitted.

(2) The contract drawings will include loading diagrams/tables showing the design wind uplift pressures for all roof zones as determined by ASCE 7, including external and internal pressures. The contract drawings will also include minimum design live loads and or snow loading diagrams/tables where appropriate. When the SSMRS is a component of a metal building system, the loading criteria for Pre-engineered Metal Building Systems will apply.

(3) Some roofing systems, such as structural standing seam roofing deck do not have the structural properties necessary to act as a diaphragm; therefore, a supplementary bracing system is required.

4.11.3.12.4 **Steel Roof Deck**. Steel roof deck shall be minimum 1½-inches deep wide ribbed and have a minimum thickness of 22 gage. The steel roof deck shall be designed per SDI specifications. The steel deck shall be used as a lateral diaphragm. Reference the following paragraph "Lateral Shear Diaphragm Design". All deck shall be fastened to the main supporting members with a minimum 5/8-inch diameter fusion welds, or power actuated or pneumatic fasteners spaced per the design requirements, but not less than 3 welds or fasteners per sheet width of deck. Weld washers shall not be used for the welded connections. Self-tapping screws will not be allowed for deck fastening to the main supporting members without CESPA prior approval. Only self-tapping screws and button punching performed by a pneumatic machine that punches through the two layers of deck ribs will be allowed to be used for the sidelap attachment of the steel deck. Button punching that uses a tool that only crimps the deck panels together will not be allowed. The steel deck can have nested or interlocking side laps. Interlocking sidelap decking using a self-tapping screw side lap attachment is not allowed unless the deck has a minimum 1/2” horizontal extension past the interlock rise of the deck to take a self-tapping screw.

4.11.3.12.5 Deck selection should include a consideration for construction and maintenance loads per the Steel Deck Institute Specification table titled “Recommended Maximum Spans for Construction and Maintenance Loads Standard for 1-1/2 Inch and 3 Inch Roof Decks”.

4.11.3.12.6 Roof joists or purlins shall not be spaced above 6’-0” on center. CESPA recommends a standard of 5’-0” on center maximum spacing.

4.11.3.12.7 **Light Gage Steel Roof Truss Systems**.

a. All truss system elements shall be pre-engineered pre-fabricated light gage cold formed steel.

b. Trusses shall be designed with web member arrangement such that members are symmetrically loaded in the plane of the truss.

c. No truss member shall be less than 20 gage thickness material.

4.11.4 **Concrete Construction**.

4.11.4.1 **Frames.** Cast-in-place or precast concrete frames may be used as vertical-load-carrying or lateral-load carrying moment resisting frames with restrictions on their design for use in resisting seismic forces. Table 7-1 of UFC 3-310-03A identifies the type of moment resisting concrete framing required for each Seismic Design Category. Use of precast seismic-force-resisting frames is permitted, provided the frame emulates the behavior of monolithic reinforced concrete construction or relies on demonstrated experimental evidence that seismic loading comparable to monolithic reinforced concrete is achieved. Complete documentation shall be submitted and approved by the CESPA when precast seismic-force-resisting framing is proposed for use.

4.11.4.2 **Lightweight Concrete**. Structural lightweight concrete shall not be used for concrete construction.

4.11.4.3 **Concrete Design.** Concrete design will be in accordance with reference ACI 318 and IBC or UFC 3-310-03A as applicable.

4.11.4.4 **Building Expansion Joints**. Provide expansion joints through concrete framed buildings at a maximum 200 feet on center.

4.11.5 **Pre-Engineered Metal Buildings**.

[Editor’s Note. Delete this paragraph and all its subparagraphs if there is no pre-engineered metal building on this project.]

4.11.5.1 **Conceptual Roof Framing Plan**. A conceptual roof framing plan shall be provided in the contract drawings. This roof framing plan shall show all support frames, a tentative spacing of the roof purlins (maximum 5’-0” on center), tentative horizontal roof lateral bracing, wall vertical lateral resisting members, mechanical units, roof openings, cranes and crane supports and any other miscellaneous items associated with the roof framing plan. This plan shall be <u>FULLY</u> dimensioned and contain the grid lines that are associated with the foundation plan.

4.11.5.2 **Overall Building Sections**. Overall building sections for each different configuration of the building frames shall be included in the contract documents. These sections shall include the roof pitch, the height requirement to the interior intersection point of the column/beam haunch of the frames, the pertinent grid lines associated with the sections, and any special instructions to the pre-engineered metal building manufacturer. The width dimensions of the frame are not needed on the sections.

4.11.5.3 **Standing Seam Metal Roofing Panels**. Special attention shall be given to providing adequate support for the standing seam metal roofing panels in accordance with UFC 3-320-03A.

4.11.6 **Special Structures**. Special structures can include but not necessarily limited to antenna platforms and catwalks.

4.11.6.1 **Antenna Platform(s**). Special attention shall be given to any antenna platforms located on roof areas. The dead load and lateral loads of the antenna have to be coordinated with the Corps project manager during the design process.

4.11.6.2 **Catwalks**. Special attention needs to be given to catwalks. Catwalks shall be constructed of structural steel and open grating.

4.11.7 **Lateral Shear Diaphragm Design.**

4.11.7.1 **Steel Deck Diaphragms.** Steel deck diaphragms for both wind-controlled and seismic-controlled designs shall be designed in accordance with SDI Specifications and the IBC or UFC 3-310-03A.

4.11.7.1.1 The selected deck thickness, deck section properties and fastening requirements shall be placed on the drawings, as shown in CESPA Standard Structural Drawing Sheet S003, “General Structural Steel Notes”.

4.11.7.1.2 Steel deck diaphragms usually fall in the flexible or semi-flexible category and, as such, will not distribute torsional forces, i.e., diaphragm shear reactions at shear walls or frames will be computed on a tributary area basis only.

4.11.7.1.3 The lateral deflection of steel deck diaphragms, which furnish lateral support for masonry walls, should be checked against the allowable wall deflection. Reference TM 5-809-3 for the computation of the allowable deflection for masonry walls. The actual maximum wall deflection is equal to the "story drift" that is the sum of the maximum diaphragm deflection and the average of the deflections of the frames or shear walls on either side of the diaphragm span.

4.11.7.1.4 Structural connections of the steel deck diaphragms to the building frame, sidelap connections, perimeter chords, connector plates at ridges, shear struts/collectors buildings to carry loads to shear walls and braced frames and other details for proper behavior of the diaphragm shall be fully designed and detailed on the contract drawings.

4.11.7.1.5 All deck shall be fastened to the main supporting members with a minimum 5/8-inch diameter fusion welds, or power actuated or pneumatic fasteners spaced per the design requirements, but not less than 3 welds or fasteners per sheet width of deck. Weld washers shall not be used for the welded connections. Self-tapping screws will not be allowed for deck fastening to the main supporting members without CESPA prior approval. Only self-tapping screws and button punching performed by a pneumatic machine that punches through the deck ribs will be allowed to be used for the sidelap attachment of the steel deck. The steel floor deck can have nested or interlocking side laps. Interlocking sidelap decking using a self-tapping screw side lap attachment is not allowed unless the deck has a minimum 1/2” horizontal extension past the interlock rise of the deck to take a self-tapping screw. A button punching tool that only crimps the deck panels together will not be allowed.

4.11.7.2 **Concrete Floor or Roof Diaphragms.** For seismic designs, the criteria listed in the IBC or UFC 3-310-03A shall be followed. The criteria may also be used as a guide in designing diaphragms for wind-controlled designs. Concrete diaphragms shall be designed as "rigid" diaphragms.

4.11.7.3 **Precast Concrete Floor or Precast Concrete Roof Diaphragms.** Calculations must be included in the design analysis to demonstrate the adequacy of the side connections to transmit shear and connection of the precast concrete diaphragms to the lateral force resisting building framing or shear walls.

4.11.7.4 **Roof Diaphragms.** For seismic designs, the criteria listed in the IBC or UFC 3-310-03A shall be followed. The criteria may also be used as a guide in designing diaphragms for wind-controlled designs. Roof diaphragms shall be designed as flexible or rigid diaphragms depending on whether there is concrete on the deck or not. If “concrete” the diaphragm shall be designed as a “rigid” diaphragm. The lateral deflection of steel deck diaphragms that furnish lateral support for masonry walls shall be checked against the allowable wall deflection for masonry.

4.11.7.5 **Shear Struts.**

4.11.7.5.1 One common error in design of shear diaphragms is the failure to provide struts where needed to allow uniform shear transfer from the diaphragm. Such cases arise where a shear wall or frame does not extend for the full depth of a diaphragm and at re-entrant corners of "L" and "T" shaped buildings.

4.11.7.5.2 Shear struts, if used, shall be designed for the horizontal compressive or tensile loads from the accumulated diaphragm shear as well as vertical loads. If the strut is a joist, then provide the required axial loads on the drawings so the joist manufacturer can design the joist for the required axial loading. Use shear stud connectors for the shear strut connection to the concrete deck if a concrete deck is used as the diaphragm.

4.11.7.5.3 Connections between struts and shear walls or frames shall be fully designed in the structural calculations and detailed on the drawings. The connection of the shear strut to a masonry wall, if the shear strut is a steel beam, is an exception to the rule that all beams that rest on masonry walls shall have expansion joint bearing connections. See the previous paragraph titled “Steel beams bearing on masonry or concrete walls”.

4.11.8 **Structural Load-Bearing and Lateral Shear Walls.**

4.11.8.1 **Exterior Wall Design Requirements**. Exterior masonry or concrete walls shall be designed to withstand wind and/or seismic lateral loads while spanning vertically from floor to floor (or roof) or horizontally between columns, pilasters or intersecting walls. The wall design wind load shall be determined from the worst possible combination of exterior and interior pressures (either inward or outward) and other provisions of ASCE 7. Seismic loads for structural and architectural components shall conform to the IBC or UFC 3-310-03A.

4.11.8.2 **Interior Wall Design**. Interior partitions shall be designed to withstand minimum lateral pressures as specified in ASCE 7 and can span either vertically or horizontally. If spanning vertically, partitions must be supported at the top of the wall by the roof or floor structural components using vertical slip connections.

4.11.8.3 **Masonry Walls**.

4.11.8.3.1 Masonry for buildings shall be detailed to show required thickness, vertical reinforcement size and spacing, dowels, pilaster depth, reinforcement and ties, wall stiffeners adjacent to openings, lintel depth, reinforcement and end bearing dimensions, bond beam spacing and reinforcement, joint reinforcement spacing and size, and control joint locations and details. When walls are curtain walls show details of masonry connections to the roof or floor diaphragms components.

4.11.8.3.2 Masonry Notes and Standard Details. Masonry notes and standard details shall be placed on the contract drawings as shown in CESPA Standard Structural Drawing Sheet S004.

4.11.8.3.3 Masonry walls and partitions shall be designed in accordance with UFC 3-310-05A and the IBC or UFC 3-310-03A, as applicable.

4.11.8.3.4 Unreinforced masonry structural walls are not allowed.

4.11.8.3.5 Specify and Design for Type "S" Mortar. The mortar shall be Type “S” mortar. The mortar shall contain the manufacturers recommended amount of liquid polymeric integral water repellant mortar admixture for water repellency and assure proper bond strength.

4.11.8.3.6 Minimum Reinforcement. All masonry walls shall be reinforced as specified in UFC 3-310-05A and the IBC or UFC 3-310-03A.

Vertical reinforcement for masonry walls, 10-inches or less in thickness shall contain no more than one reinforcing bar per grouted cell with the bar located in the center of cell. See CESPA Standard Structural Drawing Sheet S004, Detail "A" for minimum seismic reinforcement placement details.

4.11.8.3.7 Masonry single wythe interior partitions and walls shall be minimum 6-inches thick and shall be reinforced.

4.11.8.3.8 Where roof or floor diaphragms are attached to bond beams that serve as the diaphragm chord, the bond beam reinforcement shall be continuous across the wall control joints. If the wall is exposed to view, provide a "dummy joint" in the bond beam to match the control joint location. If a continuous ledger angle attached to the wall functions as the diaphragm chord, then the angle shall be continuous across the wall joints.

4.11.8.3.9 Wall control joints and other crack control measures shall be in accordance with UFC 3-310-05A and the IBC or UFC 3-310-03A, as applicable. The joints shall not exceed a spacing of 30-feet on center, and shall be at least 24-inches from the edge of any wall opening and shall not be placed within the span of a lintel. Show control joint locations on architectural plans and elevations in the contract drawings (not on the Structural drawings). Incorporate the control joint details in the contract drawings as shown in CESPA Standard Structural Drawing Sheet S004, Details B and C. All bond beam reinforcing shall stop at the wall control joints unless the bond beam is used as a diaphragm chord.

4.11.8.3.10 Vertical and horizontal reinforcement requirements for masonry walls shall be clearly indicated on the structural drawings. Horizontal reinforcing shall be minimum 2-#4 bars in knockout bond beams. The bond beams shall be spaced at 48-inches on center maximum. With bond beams at 48-inches on center, it is not necessary to use horizontal joint reinforcing. One #4 hooked dowels shall be installed in the top of all masonry walls at each vertical wall cell containing vertical reinforcing. The dowels shall project 24-inches into the wall and hook 6-inches into the wall top bond beam. These dowels will guarantee that the wall top bond beam will be attached to the lower portion of the wall. Bond beams at sloped wall conditions shall be detailed as shown on the CESPA Standard Structural Drawing Sheet S004.

4.11.8.3.11 Masonry walls shall be kept clear of steel columns and steel beams a minimum of 1/2-inch.

4.11.8.4 **Precast Concrete Walls**. Precast or site-cast (tilt up) walls may be used for curtain walls or load-bearing and/or shear walls.

4.11.8.4.1 These types of walls shall be designed in accordance with PCI Design Handbook, Precast and Prestressed Concrete, and PCA Engineering Bulletin, Tilt-up Load Bearing Walls. Also, reference CESPA guide specification Section 03 45 01 – PRECAST ARCHITECTURAL CONCRETE for CESPA specific precast concrete requirements.

4.11.8.4.2 Precast panels will be designed for in-place loads similar to other building elements with the required steel reinforcing.

4.11.8.4.3 The detail connections between the panels and the building framing shall be fully designed and detailed by the EOR.

4.11.8.4.4 The EOR shall design all precast units for in-place loadings. Any additional reinforcing for handling, shipping, transportation or erection is the responsibility of the precast unit manufacturer.

4.11.9 **Structural Steel Stud Walls, Soffits and Fascia**.

4.11.9.1 **General**.

4.11.9.1.1 Structural steel studs may be used for interior and exterior load bearing and non-load bearing walls and for soffits and fascia framing construction in accordance with UFC 3-310-04A.

4.11.9.1.2 Design calculations for steel stud walls, soffits and fascia framing shall be included in the Design Analysis.

4.11.9.2 **EOR Responsibility**. The building structural EOR has design responsibility for cold-formed steel systems and this responsibility will not be transferred to the Construction Contractor.

4.11.9.3 **Steel Stud Contract Drawings**.

4.11.9.3.1 Structural steel stud walls, soffits and fascia should be detailed to show steel stud, steel joist spacing and required physical properties including depth, thickness, moment of inertia, section modulus. Assembly details to show wall top and bottom tracks along with their required physical properties and their connections to floors or other framing. Details including required web stiffeners, foundation clips, end clips, joist hangers and the required number and size of connecting screws and/or weld size and length shall be included. Framing around openings shall be detailed to show headers, nested double/triple members on sides of openings. Diagonal bracing and its connection to foundation and the steel stud assembly framing shall be fully detailed when required for building structural stability. Intermediate bridging for lateral support of studs/joists needs to be fully detailed. For bracing details reference UFC 3-310-04A.

4.11.9.3.2 The contract drawings shall show all components of the steel stud walls, soffits or fascia systems. Special attention should be given to the design in the structural calculations and detailing in the drawings of steel studs for soffit framing with bracing and connections (welds and screws). The connections shall be completely detailed on the drawings.

4.11.9.3.3 Design and detail the connections between steel stud framing and the main structural system to prevent the studs from carrying floor or roof axial or shear loads if the walls are non-load bearing.

4.11.9.3.4 Contract drawings shall specify the required stud depth, spacing, gage, section modulus and moment of inertia in the structural notes as shown in CESPA Standard Structural Drawing Sheet S003, "Structural Steel Stud Wall Notes".

4.11.9.4 **Minimum Member Thicknesses**. Steel studs shall be a minimum of 18 gage thickness material. Steel track shall be fabricated from a minimum of 14 gage thick material, except for load bearing steel stud walls the top track supporting the roof or floor joists or trusses shall be a minimum 12 gage material. Use #12 self-tapping screws for the connections of 18 gage studs. Do not weld 18 gage thick material. Sixteen gage and thicker studs can be attached with weld or #12 self-tapping screws.

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